Executive Summary
Tools-in-Use Survey: Patterns of Tool Use
among Manufacturing Extension Field Staff

The Modernization Forum surveyed 501 manufacturing extension center field staff from its National Conference database in late 1996 and early 1997 about what tools they use when working with customer firms. The results, based on responses from more than 50 percent of those surveyed, offer the first solid quantitative data on the extent and patterns of tool use by extension centers. The Modernization Forum carried out this research in collaboration with the Southern Technology Council and with funding from the Industrial Technology Institute as part of a larger ITI tools evaluation project supported by the Manufacturing Extension Partnership program of the National Institute of Standards and Technology. For the survey, tools were defined as structured and transferable methods, materials, software and training course content that field staff use to perform functions or guide decisions on projects for customers.

Tools Used

More than 70 percent of the 233 individuals who returned completed tools-in-use questionnaires reported that they use tools in their extension work with smaller manufacturers. The questionnaire included a list of tools likely to be used by field staff and asked respondents to indicate which of these they use and how often. The survey found that Performance Benchmarking and QuickView-- two tools used for initial, overall assessments--have the highest levels of use, with 67 percent of the 165 respondents who employ tools reporting use of Performance Benchmarking and 64 percent of them reporting use of QuickView.

The survey results also show relatively high levels of use for other overall assessment tools, which help field staff systematically investigate circumstances and improvement opportunities throughout the customer firm. Overall assessment tools--both initial and in-depth methodologies--account for seven of the 22 tools used by 5 percent or more of the tool users who responded to the survey, and they account for five of the top 11 slots. Another 7 of the top 22 tools, rated by the number of users, are subject-specific assessment tools that allow field staff to carry out assessments focused on specific topics rather than overall operations.

Table ES-1 on the next page lists the 22 tools used by 5 percent or more of the tool users who responded to the survey, plus another seven tools either identified by three or more respondents as among the most useful tools for manufacturing extension work, or used by three or more of the most experienced respondents. The first 22 tools are ranked according to the number of users and include an equal number of tools developed by manufacturing extension centers and for-profit companies.

As the table shows, data on the number of users indicates that other popular types of tools include software selection methodologies that help manufacturers identify appropriate systems for business, CAD/CAM and manufacturing control; and tools for simulating production and mapping flow. Software selection tools account for four of the 22 most used tools, and simulation and mapping tools account for three of them. (For complete information on which tools from *Table ES-1* are what type, refer to the full report on this tools-in-use survey.)

Table ES-1
Notable Tools for Manufacturing Extension

Name of Tool	User Count for Tools Used by 5% or More of the Tool Users	Cite Count for Tools Cited by 3 or More Respondents as Most Useful to Extension Work	Experienced User Count for Tools Used by 3 or More Experienced Respondents
Performance Benchmarking	111	65	26
QuickView	105	57	21
fisCAL	45	21	11
Factory CAD, Flow, Plan	32	6	10
Software Selection Tool (SoftSelect Software)	32	15	8
SITE Assessment	30	14	3
Z Score	28	---	6
CTS Guide to PC-Based Software	26	6	4
OSHA Self-Inspection Checklist	23	---	4
High Impact Assessment and BI-FAR	22	18	5
Manufacturing Assessment Methodology	21	7	7
BizPlan Builder	19	---	5
ProModel	18	4	4
BuySmart/ChooseSmart	16	---	7
ISO 9000 Checklist from Georgia Tech	14	3	6
Energy, Environmental and Mfg Assessment	13	3	---
CAD Rating Guide	12	---	3
SAGE	12	---	---
Competitiveness Review	11	6	---
CorelFLOW	11	---	3
DISC--Personality Profile for Managers	10	---	5
PRISM Manufacturing Assessment	10	6	4
Human Resources Assessment Protocol & Mini	---	5	5
CTS Cost-Justifier for Manufacturing	---	3	---
ISO Score	---	3	---
Microsoft Project	Not listed	3	---
TECnet (information resource)	Not listed	3	---
Work Profiling System	Not listed	3	---
Total Quality Joining Assessment Methodology	---	---	3

Most Useful Tools

The tools-in-use questionnaire asked respondents to list the tools they consider to be most useful, and the second data column of *Table ES-1* shows the number of write-ins for the 20 identifiable tools cited by at least three of the respondents. Once again, Performance Benchmarking and QuickView lead the list. Six of these 20 tools failed to turn up on the list of tools used by 5 percent or more of the tool users--three because too few respondents checked them off the survey list of tools,

but three others probably because they were not included on the list. (Microsoft Project and TECnet were not listed because the Modernization Forum did not include information resources and project management tools in the survey.) Eight tools that are used by 5 percent or more of the tool users failed to win recommendations from three or more respondents.

Tool Use by Experienced Extension Staff

Of the tool users who responded to the survey, 38 had three or more years of manufacturing extension experience. *Table ES-1* includes 21 tools used by at least three of these experienced field staff. Most of these tools are the same as those used by all survey respondents, with the additions of the Human Resources Assessment Protocol and the Total Quality Joining Assessment Methodology.

Tools Evaluation Criteria

The questionnaire presented respondents with a list of 10 tool characteristics and asked them to rate the significance of each to the positive evaluation they give their favorite tool. The top six criteria are as follows: 1) widely applicable, 2) performs accurately, 3) saves time and money, 4) is easy to use, 5) costs relatively little, and 6) maintains quality across projects for different customers. The scores for these characteristics fell within the same statistical range and therefore may be considered equal in value.

Barriers to Use

The survey found the two most significant barriers to tool use to be 1) a lack of information about tool performance, and 2) a lack of information about tools. Aggregate results from a survey question about potential barriers also indicates some concern among field staff regarding the price of tools and their accuracy, and some difficulties with sorting through all the tools and deciding which to use. Respondents reported that the two most common sources of information about tools are informal ones close to home--other manufacturing extension field staff and extension center directors and managers.

Recommendations

The Modernization Forum recommends the following based on survey findings:

- Manufacturing extension centers and field staff should be made aware of the tools listed in *Table ES-1* and provided with information both about these tools and their performance.

- Organizations interested in fostering the effective use of manufacturing extension tools must find better ways of disseminating tools information to field staff.

- Centers and field staff need to hear about and look for tools both from within the manufacturing extension system and from organizations and commercial companies outside of it.

- In the interests of gathering valuable information about tool use strategies, tools evaluation and effective methods for disseminating information about tools, there should be further analysis of the survey data and additional research into the practices of centers and field staff who use many tools often.

Manufacturing Extension Tools and Their Use

Field staff at manufacturing extension organizations provide comprehensive, hands-on, technical support to small and midsize manufacturers as they upgrade equipment, improve production processes and strengthen business performance. As they strive to reach and assist a significant portion of the nation's 381,000 smaller manufacturing establishments, extension centers and the manufacturing experts who staff them constantly search for ways to improve the effectiveness and efficiency of their service delivery.

Over the years, many manufacturing extension centers have adopted, adapted or developed tools that allow them to leverage existing expertise and better ensure consistent, high quality service delivery for their customers. These manufacturing extension tools are structured and transferable methods, materials, software and training course content that field staff use to perform functions or guide decisions when working with customer firms. Some examples include assessment procedures for identifying priority improvement projects, software for simulating the impact of changes in plant floor layout, and software for helping a manufacturer select the appropriate information systems for business operations and manufacturing control. Taken as a group, extension tools function as decision aids that help field staff carry out their work with smaller manufacturers.

Up until now, little information had been collected about the use of manufacturing extension tools by field staff. No aggregate numbers were available, for example, on what tools field staff use. This Modernization Forum report presents information about tool use gathered under contract to the Industrial Technology Institute (ITI) in Ann Arbor, MI, as part of that organization's tools evaluation project, funded by the Manufacturing Extension Partnership program of the National Institute of Standards and Technology. The research effort described in this report was designed to address the following questions:

- What tools do field staff use when they work with customer firms?
- How frequently do they use these tools?
- What tools do they consider most useful to their work?
- What criteria do they use to evaluate tools?
- What are the barriers to their use of tools?
- What functions do they want to have tools for?

The Southern Technology Council (STC) assisted the Modernization Forum in this effort.

Research Methodology

To investigate these tools issues, the Modernization Forum worked with the ITI tools evaluation project team and advisors at STC to carry out a tools-in-use survey of manufacturing extension field staff and analyze the results. The Modernization Forum drew a sample of 501 field staff for the survey using its 1996 National Conference database, the only existing database with names, titles and addresses for hundreds of manufacturing extension staff. Field staff attendance at the Modernization Forum National Conference is representative of the total population of extension center field staff because the conference draws participants from the vast majority of U.S. manufacturing extension organizations, including almost all NIST MEP centers.

For the survey, the Modernization Forum extracted from the conference database only those individuals affiliated with its member organizations--all not-for-profit manufacturing extension

organizations whose primary purpose is to provide technical assistance and services to modernizing small and midsize manufacturers in the United States. Furthermore, the database listings were reviewed to eliminate individuals with titles such as director, president, regional manager, marketing manager, operations manager, events coordinator, evaluation specialist and other designations indicating primary duties aside from field work with customer firms.

In December 1996, the Modernization Forum mailed a five-page survey questionnaire with a personalized cover memo to each of the 501 individuals from the conference database identified as likely field staff. The survey questionnaire consisted of more than 100 items that explored the use of tools, barriers to tool use, desired functional purposes for tool use, tool use patterns for 63 specific tools, preferred tools, tools evaluation criteria, and sources of information on tools. (For a copy of the questionnaire, see *Appendix A*.) A second mailing was sent out in late December to non-respondents after 115 questionnaires had been returned.

Of the 501 individuals surveyed, 252 answered, yielding a response rate of 50.3 percent. In 19 cases, the responses indicated that the questionnaire was not applicable to the respondents, usually because the addressee did not work with customer firms or was no longer employed at the manufacturing extension center. In total, the Modernization Forum received 233 completed questionnaires before the return deadline of January 8.

While the respondents to this tools-in-use survey are representative of manufacturing extension center field staff nationwide, it is worth noting that they were not drawn from a random sample of the full field staff population. No mailing list for the full population exists. Consequently, the patterns of extension center attendance at the Modernization Forum 1996 National Conference may have some influence on the results of the survey. For example, the survey data may overstate or understate field staff familiarity with and use of a tool developed at an extension center that sent a disproportionate number of its field staff to the conference. However, a review of both respondents by center and tool use data surfaced no obvious distortions in this regard.

The Use of Manufacturing Extension Tools

Responses to the survey indicate that field staff do indeed use tools. A total of 165, or 70.8 percent, of the 233 respondents reported that they use manufacturing extension tools when they work with customer firms. (See *Figure 1*.)

The survey instructions asked respondents who do not use tools to complete only the first page of the questionnaire and respondents who do use tools to fill out all five pages. Nevertheless, there was some concern that non-users might have been less likely than users to complete the tools questionnaire, thus skewing the results for this question and overstating the extent of tool use among field staff. However an e-mail follow-up sent to a random sample of non-respondents suggested a consistent pattern of tool use. The e-mail, asking only for a yes or no answer to the question of tool use, was sent to 72 non-respondents. Of the 18 responding to this follow-up, almost 80 percent (14) reported that they use tools and just over 20 percent (4) said they do not. In four cases, the non-respondents were no longer working at the extension centers.

Figure 1: Do you use tools'

No 29%

Yes 71%
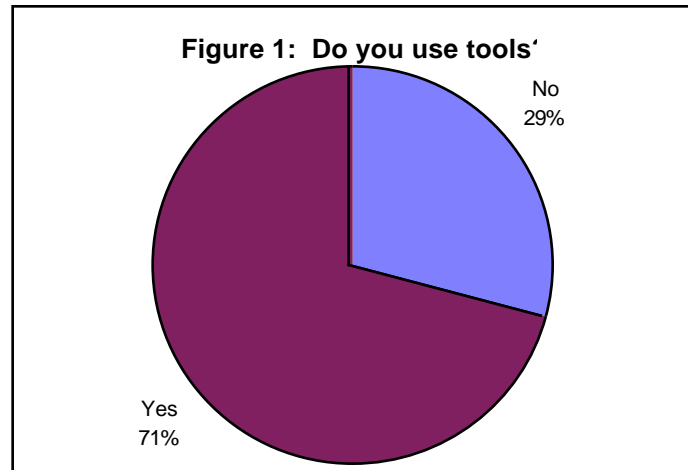
Gauging Use of Specific Tools

The tools-in-use survey included a three-page listing of 63 tools likely to be used by field staff at extension centers. To construct this list, the Modernization Forum drew upon several published sources, including its own *Assessment Tool Matrix* (December 1995) and *Tool Development Priorities for Manufacturing Extension Centers* (June 1995), *Information Tools for Industry* (1996) from STC, *Tools of Our Trade* (1996) from ITI's Network for Excellence in Manufacturing (NEM), *Software for Simulation* (Banks, 1995) from the Georgia Institute of Technology, and the *Electronic Commerce Deployment Toolkit* (October 1996) from ITI's Center for Electronic Commerce. In addition to these sources, the Modernization Forum tapped institutional knowledge and notes from past tool projects.

The three-page tools listing that resulted included the following:
- Tools known to be used at more than one manufacturing extension center
- Tools known to be used at one center and available for use by other centers--thus excluding in-house tools that do not circulate
- Tools reviewed or cited by extension center staff and available for use by more than one center
- Tools included in more than one of the published sources
- Several additional EDI tools from the *Electronic Commerce Deployment Toolkit*

The list excluded reference books, information sources, training courses and tools that centers use for operational issues rather than customer service. It included suggestions from several field staff who reviewed the draft questionnaire. It also allowed respondents to write in tools not found on the list. (For a list of tools written in by respondents, see *Appendix B.*)

The survey question that listed these 63 tools was structured to determine what tools field staff use and how frequently they use them. It included a response option for respondents to select if they were unfamiliar with a tool.

The Tools Used: Assessment Tools Dominate

Table 1 below lists the 22 tools used by more than 5 percent of the tool users who responded to the survey and ranks them by the number of respondents using each tool. (The other 41 tools named in the questionnaire were used by fewer than 5 percent of the respondents. For a full listing of the tools and number of users, see *Appendix C*.)

Table 1
Top Tools by Number of Respondents Using Them

Name of Tool	Number Using Tool	Percentage of Tool Users Using This Tool	Rank
Performance Benchmarking	111	67.3	1
QuickView	105	63.6	2
fisCAL	45	27.3	3
Factory CAD, Flow, Plan	32	19.4	4
Software Selection Tool from NCMS/GLMTC	32	19.4	5
SITE Assessment	30	18.2	6
Z Score	28	17.0	7
CTS Guide to PC-Based Software	26	15.8	8
OSHA Self-Inspection Checklist	23	13.9	9
High Impact Assessment	22	13.3	10
Manufacturing Assessment Method	21	12.7	11
BizPlan Builder	19	11.5	12
ProModel	18	10.9	13
BuySmart/ChooseSmart	16	9.7	14
ISO 9000 Checklist from Georgia Tech	14	8.5	15
Energy, Environment & Mfg Assessment	13	7.9	16
CAD Rating Guide	12	7.3	17
SAGE	12	7.3	17
Competitiveness Review	11	6.7	19
CorelFLOW	11	6.7	19
DISC--Personality Profile for Managers	10	6.1	21
PRISM Manufacturing Assessment	10	6.1	21

The survey grouped tools according to type, and the 10 listings for overall assessment tools registered a higher average number of users than the tools in any other grouping. Overall assessment tools help field staff systematically investigate circumstances and improvement opportunities throughout a manufacturer's operations. The counts for average number of tool users per tool group are as follows:

Average Number of Tool Users for Each Tool Type

- Overall assessment tools (10 tools): 32.9
- Financial (4 tools): 20.5
- Systems for business, CAD/CAM, manufacturing control (5 tools): 17.8
- Process improvement, plant layout and manufacturing cells (12 tools): 8.4
- Quality and inspection (3 tools): 7.0
- Environmental, energy and regulation (10 tools): 6.9
- Human resources (5 tools): 5.6
- Production planning and scheduling (3 tools): 3.7
- EDI/communications/LAN (6 tools): 3.5
- Business planning and marketing (3 tools): 3.4

Half of the top 10 tools, measured by number of users, are ones developed by manufacturing extension centers: Performance Benchmarking, QuickView, Software Selection Tool from GLMTC/NCMS (this tool is now owned by a for-profit company), SITE Assessment, and the High Impact Assessment. Three others from the top 10 are the products of private, for-profit companies--fisCAL; Factory CAD, Factory Flow and Factory Plan; and CTS Guide to PC-Based Software for the Manufacturing Industry. Of the remaining two, Z Score was developed at a university and is available at no charge as shareware, and the OSHA Self-Inspection Checklist comes from a federal government agency. The NIST MEP has invested in the development of two of the top 10 tools--Performance Benchmarking and QuickView. For the full list, nine of the tools were developed at centers, nine are commercial products from for-profit companies, two are from government agencies and one is free shareware.

Performance Benchmarking and QuickView

Two tools used for initial, overall assessments--Performance Benchmarking and QuickView-- stand out from the list for the number of respondents who use them. About two-thirds of the 165 tool users who responded to the survey report that they use at least one of these tools. With their combined count of users at 216, Performance Benchmarking and QuickView have as many users as the next seven tools in *Table 1* combined. Interestingly 67 respondents reported that they use both of these initial, overall assessment tools. This count of dual-users amounts to 60.4 percent of the respondents who use Performance Benchmarking and 63.8 percent of the QuickView users. This high level of overlap provides strong indication that the two tools are distinct enough to be appropriate for different types of firms or at different points in their interaction with field engineers. Otherwise a tool user would likely turn to one tool or the other and use it with each customer. Instead many of the users are picking and choosing between Performance Benchmarking and QuickView, presumably based on the needs and circumstances of the customer firm.

Overall Assessment Tool in General

Overall assessment tools in general are popular among the survey respondents, accounting for seven of the 22 tools listed in *Table 1*. Overall assessment tools captured five of the top 11 slots--Performance Benchmarking, QuickView, SITE Assessment, High Impact Assessment, and Manufacturing Assessment Methodology. This pattern of tool use undoubtedly reflects the role of the extension center field engineers in identifying top priority improvement projects for customer firms and recommending appropriate actions.

Other Subject-specific Assessment Tools

Many other tools listed in *Table 1* also allow field staff to conduct assessments but with a focus on specific topics rather than overall operations. Field staff use these subject-specific assessment tools to investigate circumstances and identify improvement opportunities for a manufacturer within distinct areas.

The third-ranked fisCAL and sixth-ranked Z Score focus on financial issues. Patterns of use for these tools demonstrate that extension center field staff must help manufacturers grapple with issues beyond production and technology. It is worth noting that the High Impact Assessment, one of the overall assessment tools used by many survey respondents, includes a stand-alone assessment, called BI-FAR, that builds on fisCAL and focuses on financial issues for manufacturers.

The OSHA Self-Inspection Checklist, ranked ninth, assesses health and safety issues, and the 15th-ranked ISO 9000 Checklist from Georgia Tech examines quality. The Energy Environmental and Manufacturing Assessment looks at production issues with a focus on reductions in energy use and waste. DISC--Personality Profile helps assess human resources issues.

Software Selection Tools

Four of the 22 tools listed in *Table 1* allow field staff to help manufacturers select appropriate software systems for business, CAD/CAM and manufacturing control. This is an area of high demand for many extension centers. In a broad sense, these tools also may be considered assessment tools because they help determine the firms' needs and then match those needs up with potential solutions and produce recommendations.

Two of these software selection tools rank among the top ten for number of users--Software Selection Tool: Business Systems from the National Center for Manufacturing Sciences (NCMS) and the Great Lakes Manufacturing Technology Center (GLMTC) at fifth, and CTS Guide to PC-Based Software for the Manufacturing Industry at eighth. BuySmart/ChooseSmart and the CAD Rating Guide are the other two software selection tools among the 22 tools listed.

The Software Selection Tool: Business Systems from NCMS/GLMTC was developed by Mike Rastatter and Paula Volpini at GLMTC for NCMS and made available for use by extension centers in June 1996. The number of respondents who report using this tool is surprisingly high given its short history. It is possible that a few of the respondents overlooked the full listing of the tool name when reading through the questionnaire and selected it under the assumption that the first part of the name, "The Software Selection Tool," was a generic title for software selection tools in general. The tool itself was recently sold to SoftSelect Systems and renamed SoftSelect Software.

Tools for Simulating Production and Mapping Flow

The survey results show that software and methodologies for simulating production and mapping flow are another popular type of tool. Field staff use these tools to analyze potential improvements in production processes and plant layout. *Table 1* includes three such tools--the fourth-ranked Factory suite (Factory CAD, Factory Flow, Factory Plan), 13th-ranked ProModel, and 19th-ranked CorelFLOW. The Factory suite's high score may stem in part from the fact that the questionnaire listed Factory CAD, Factory Flow and Factory Plan together as one tool for space reasons.

Other Tools

Two other tools used by more than 5 percent of tool-using respondents are listed on *Table 1*. The 12th-ranked BizPlan Builder steps firms through the process of creating a business plan. The 17th-ranked SAGE, or Solvent Alternatives Guide, helps manufacturers engaged in cleaning processes determine alternatives to use in place of environmentally harmful solvents.

Patterns of Use among Respondents Familiar with the Tools

A focus solely on the number of respondents who use a tool ignores the obvious fact that use of a tool is affected by how many respondents know about it. Take, for example, a tool that many field staff know about but that most of them decide not to use. The actual number of users constitutes a small share of the large group in the know about this tool. By contrast, very few field staff may know about another tool, but almost all of them may choose to use it. If these two tools were rated according to the number of users, the well-known tool quite likely would rank higher than the lesser-known tool even though more people than not decide against using this first tool, while more people than not decide to use the second tool.

To control for differences in familiarity from tool to tool, the Modernization Forum determined what percentage of all the respondents who knew about each tool also used it. *Table 2* on the next page again shows the 22 tools used by more than 5 percent of the survey respondents but ranks them according to this percentage. Performance Benchmarking and QuickView still weigh in as tools one and two, each with more than 70 percent of those familiar with it using it. This approach to ranking moves several tools up from their standing in *Table 1*, which ranks tools by the number of users. In *Table 2*, BizPlan Builder and the CAD Rating Guide climb into the top 10, while the SITE and High Impact Assessments drop down somewhat.

Table 2
Top Tools Ranked by Users as a Share of Those Familiar with the Tool

Name of Tool	Users as a Percentage of Those Familiar with the Tool	Rank	Number Familiar with Tool	Number Using Tool	Rank for No. of Users
Performance Benchmarking	75.5	1	147	111	1
QuickView	70.5	2	149	105	2
Software Selection Tool from NCMS/GLMTC	60.4	3	53	32	5
CTS Guide to PC-Based Software	52.0	4	50	26	8
fisCAL	50.0	5	90	45	3
Z Score	49.1	6	57	28	7
BizPlan Builder	44.2	7	43	19	12
Factory CAD, Flow, Plan	42.7	8	75	32	4
CAD Rating Guide	38.7	9	31	12	17
OSHA Self-Inspection Checklist	37.7	10	61	23	9
SITE Assessment	35.3	11	85	30	6
ProModel	35.3	11	51	18	13
BuySmart/ChooseSmart	34.0	13	47	16	14
High Impact Assessment	32.8	14	67	22	10
Manufacturing Assessment Method	32.8	14	64	21	11
DISC--Personality Profile for Managers	31.3	16	32	10	21
SAGE	30.8	17	39	12	17
ISO 9000 Checklist from Georgia Tech	25.9	18	54	14	15
Energy, Environment & Mfg Assessment	23.6	19	55	13	16
Competitiveness Review	22.9	20	48	11	19
CorelFLOW	22.9	20	48	11	19
PRISM Manufacturing Assessment	16.4	22	61	10	21

Frequency of Tool Use

The survey questionnaire asked respondents to use the following scale to indicate how frequently they used each tool with customer firms:

   1 = Never use (with 0 percent of customer firms)
   2 = Rarely use (with 1-10 percent of customers)
   3 = Sometimes use (with 11-25 percent of customers)
   4 = Often use (with 26-50 percent of customers)
   5 = Usually use (with more than 50 percent of customers)

Data from the survey provide useful information about how often field staff use the different tools. *Table 3* lists the 22 tools used by more than 5 percent of the survey respondents ranked

by the average frequency score. These calculations are based only on data from respondents who rated a tool at 2 or higher and thus actually used it.

Table 3
Top Tools by Frequency of Use

Name of Tool	Average Frequency Score	Number Using Tool
Competitiveness Review	3.5	11
High Impact Assessment	3.3	22
PRISM Manufacturing Assessment	3.3	10
Z Score	3.1	28
QuickView	3.0	105
ISO 9000 Checklist from Georgia Tech	3.0	14
Energy, Environment & Mfg Assessment	3.0	13
BizPlan Builder	2.9	19
CTS Guide to PC-Based Software	2.9	26
CorelFLOW	2.9	11
Factory CAD, Flow, Plan	2.8	32
Performance Benchmarking	2.8	111
Software Selection Tool from NCMS/GLMTC	2.8	32
fisCAL	2.7	45
BuySmart/ChooseSmart	2.6	16
ProModel	2.6	18
SITE Assessment	2.6	30
Manufacturing Assessment Method	2.6	21
OSHA Self-Inspection Checklist	2.6	23
DISC--Personality Profile for Managers	2.5	10
CAD Rating Guide	2.3	12
SAGE	2.1	12

All the tools that scored on average 3.0 or higher for frequency of use are assessment tools--either overall assessment tools or subject-specific ones. Again this is not surprising because much of the work performed by manufacturing extension field staff involves investigating the circumstances for a customer firm and identifying priority improvement projects.

Interestingly these calculations show that respondents use the popular Performance Benchmarking and to a lesser extent QuickView more infrequently than some of the other tools. This may stem in part from the fact that those respondents most familiar with some of the other tools probably work at centers with practices or policies that encourage their use. For example, the Competitiveness Review and PRISM are used primarily by staff at two centers--the Southeast Manufacturing Technology Center and the Institute of Advanced Manufacturing

Sciences respectively--and both these centers strongly encourage their staff to employ these particular tools often.

The frequency scores also reflect the nature of the tools themselves. For example, Performance Benchmarking requires the field engineer to collect detailed data from firms and provides them with an in-depth, analytical report of 25 to 50 pages in length, which may be more than what's needed in some cases for the early interactions between a field engineer and a new customer. Similarly, two in-depth, time-consuming overall assessment tools--SITE and the Manufacturing Assessment Methodology--receive relatively low average scores for frequency. This is not surprising. Field experience has demonstrated that such in-depth assessments are best performed in a limited number of cases, such as when small manufacturers have undergone significant changes in ownership, technology or market circumstances; or they face complex problems that make it difficult to determine symptoms from root causes; or they desire a long-term road map for continuous improvement (*Assessments: Identifying Improvement Priorities*, Modernization Forum, Dec. 4, 1996).

Given these considerations, the frequency-of-use scores may best be viewed not as indicators of a tool's popularity with its users but more as a rough gauge from experienced users on how often it is appropriate to apply a tool to the mix of customers that seek help from manufacturing extension centers.

Tools Used by Experienced Field Staff

The survey asked tool users to indicate how long they have worked in the field of manufacturing extension. The results of this question were cross tabulated with data on the tools used in order to determine the tool use patterns of the 38 survey respondents with three or more years of manufacturing extension experience. *Table 4* on the following page lists the 21 tools used by at least three of the experienced field staff who responded to the survey.

Most of the tools used by three or more of the experienced field staff are the same top tools identified through the counts of total of respondents using them. (See *Table 1*.) The top five most often cited by experienced respondents as tools they use is the same as the top five for overall respondents. However the list in *Table 4* for experienced users includes two tools not found on the list in *Table 1*--the Human Resources Assessment Protocol, an assessment tool focused on human resource issues, and the Total Quality Joining Assessment Methodology, an assessment tool focused on materials joining issues.

Table 4
Top Tools by Number of Experienced Respondents Using Them

Name of Tool	Number of Experienced Respondents Using Tool	Percentage of Experienced Respondents Using Tool	Rank
Performance Benchmarking	26	68.4	1
QuickView	21	55.3	2
fisCAL	11	28.9	3
Factory CAD, Flow, Plan	10	26.3	4
Software Selection Tool from NCMS/GLMTC	8	21.1	5
Manufacturing Assessment Method	7	18.4	6
BuySmart/ChooseSmart	7	18.4	6
Z Score	6	15.8	8
ISO 9000 Checklist from Georgia Tech	6	15.8	8
High Impact Assessment	5	13.2	10
DISC--Personality Profile for Managers	5	13.2	10
Human Resources Assessment Protocol	5	13.2	10
BizPlan Builder	5	13.2	10
PRISM Manufacturing Assessment	4	10.5	14
ProModel	4	10.5	14
CTS Guide to PC-Based Software	4	10.5	14
OSHA Self-Inspection Checklist	4	10.5	14
SITE Assessment	3	7.9	18
CorelFLOW	3	7.9	18
CAD Rating Guide	3	7.9	18
Total Quality Joining Assessment	3	7.9	18

Most Useful Tools for Manufacturing Extension Work

The questionnaire asked respondents to write in up to five tools that they consider to be the most useful for manufacturing extension work with customer firms. In total 130 of the 165 tool users listed at least one response to this question. *Table 5* on the next page tallies and ranks the results for all 22 tools that were written in by at least three respondents. Five respondents wrote in "CTS" without distinguishing between the CTS Guide to PC-Based Software for the Manufacturing Industry and the CTS Cost Justifier.

Once again, Performance Benchmarking and QuickView lead the list. Of the 130 respondents who answered this question, 50 percent mentioned Performance Benchmarking and 44 percent suggested Quick View. Together these tools were cited 121 times--as many times as the next 13 most-cited tools combined. Overall assessments in general dominated the list of most useful tools, accounting for six of the top 10 most useful tools as measured by the number of times

cited. (For a full listing of the tools mentioned as the most useful to extension work, see *Appendix D.*)

Table 5
Most Useful Tools Ranked by Number of Write-ins

Tool	Number of Write-ins	Rank	Number Using Tool	Percentage of the Tool's Users Who Wrote It In
Performance Benchmarking	65	1	111	58.6
QuickView	57	2	105	54.3
fisCal	21	3	45	46.7
High Impact Assessment & BI-FAR	18	4	22	81.8
Software Selection Tool from NCMS/GLMTC	15	5	32	46.9
SITE Assessment	14	6	30	46.7
ISO 9000 Checklist	8	7	14	57.1
Manufacturing Assessment Methodology	7	8	21	33.3
Competitiveness Review	6	9	11	54.5
CTS Guide to PC-Based Software	6	9	26	23.1
Factory CAD, Flow, Plan	6	9	32	18.8
PRISM Manufacturing Assessment	6	9	10	60.0
CTS (no further specification)	5	13	---	---
Human Resources Assessment Protocol & Mini	5	13	8	62.5
ProModel	4	15	18	22.2
CTS Cost Justifier	3	16	5	60.0
Energy, Environmental and Mfg Assessment	3	16	13	23.1
ISO 9000/QS9000 Gap (Analysis)	3	16	---	---
ISO Score	3	16	5	60.0
Microsoft Project	3	16	---	---
TECnet	3	16	---	---
Work Profiling System	3	16	---	---

Significant differences do exist, however, between the list of top tools ranked by the number of respondents who use them, presented in *Table 1*, and the list of tools mentioned by three or more respondents as most useful for extension work, presented in *Table 5*. Six tools found on *Table 5* either are used by less than 5 percent of all tool users who responded to the survey (Human Resources Assessment Protocol, CTS Cost Justifier and ISO Score) or were not included on the survey questionnaire's list of extension tools (Microsoft Project, TECnet and the Work Profiling System). Microsoft Project and TECnet were not listed because the Modernization Forum did not include information resources and project management tools in the survey. It is quite possible that a significant number of respondents would have identified themselves as users of the Work Profiling System had that human resources tool been included in the survey.

Table 5 also lists "ISO 9000/QS 9000 Gap," which was cited with somewhat different wording by three respondents. It is not clear if this is a tool or a short-hand reference to other quality-focused tools. Modernization Forum research on tools in 1995 also turned up references to "ISO 9000 gap analysis," but these leads were traced back to tools with other formal names.

The last column in *Table 5* compares the number of respondents who mentioned each tool as one of the most useful to extension work to the number of respondents who reported that they use that tool. The High Impact Assessment, including its BI-FAR financial analysis element, stands out by this measure, with more than 80 percent of the users suggesting it as one of the most useful tools. At the other end of the scale, less than 20 percent of those who use Factory CAD, Factory Flow or Factory Plan cited these as among the most useful.

The survey questionnaire asked respondents to circle their one favorite tool from those they listed as the most useful to extension work. Only five of the tools were circled by three or more respondents, and again Performance Benchmarking and QuickView drew the most attention:

- Performance Benchmarking (22 circles)
- QuickView (20 circles)
- High Impact Assessment & BI-FAR (7 circles)
- Software Selection Tool from NCMS/GLMTC (4 circles)
- Competitiveness Review (3 circles)

Tools Evaluation Criteria

The tools-in-use survey asked respondents to indicate how significant each of 10 tool characteristics are to the positive evaluation they give their favorite tool. The question tied the 10 tool characteristics--or evaluation criteria--back to the specific tool that respondents identified as their favorite from their list of most useful tools. By tying the criteria to a specific tool for each respondent, the Modernization Forum hoped to avoid answers for which respondents would judge any and all proposed criteria to be extremely significant in the abstract. Some who answered the question about tools criteria did not circle a favorite from their list of most useful tools.

The answers offer some indication of the most important criteria for field staff when they evaluate their preferred tools. *Figure 2* on the following page shows the average score for each of the 10 tool characteristics, or criteria, using the following scale:
    1 = Not significant
    2 = Moderately significant
    3 = Significant
    4 = Very significant
    5 = Extremely significant

While the average scores for tools criteria vary somewhat, there is little statistical significance to these differences. The Modernization Forum tested the results for statistical significance, assuming data from the respondents are extrapolated to the full population of field staff. Scores for the top six criteria all fall within the same statistical range and therefore may be considered equal in value. (For more on significance tests, see *Appendix E*.)

Figure 2: Tools Criteria

Criterion	Score
Widely applicable	~4.1
Performs accurately	~3.8
Saves time and money	~3.8
Is easy to use	~3.75
Costs relatively little	~3.7
Maintains quality	~3.5
Integrates with other tools	~3.45
Breaks the ice	~3.35
Offers training, support	~3.05
Can be use by firms	~3.0

1=Not signficant, 5=Extremely significant
(Note: Very little statistical difference among values)

The Modernization Forum also calculated the average scores for criteria from respondents who identified their favorite tool as Performance Benchmarking and compared these to the scores for respondents who identified QuickView as their top tool. No statistically significant differences existed between the responses from these two groups.

Barriers to Tool Use

The questionnaire also listed 10 potential barriers to tool use and asked respondents to indicate how significant each barrier is to their use of tools, again based on the following scale:
>   1 = Not significant
>   2 = Moderately significant
>   3 = Significant
>   4 = Very significant
>   5 = Extremely significant

As evident from *Figure 3* on the next page, the two most significant barriers to tool use are information barriers. Respondents gave average scores that fell between significant and very significant to both a lack of information about tool performance (3.8) and a lack of information about tools (3.3). These scores are statistically different from each other when tested at the 95 percent confidence level, and they are statistically different from the average scores respondents gave for the other 8 potential barriers. Interestingly there is notable overlap among the respondents who identified these information barriers as significant--96 percent of those who assigned ratings of 3 or higher to "I lack information about what tools are available" also gave ratings of 3 or higher for "I lack information about how well tools perform."   Similarly, almost 9 in 10 (86 percent) of the respondents who scored tools information at 3 or higher also rated tools performance information at 3 or higher.

Figure 3: Barriers to Tool Use

Lack tool performance info
Lack info on tools available
Too expensive to buy
May be inaccurate
Too many tools to decide
Add little to what I know
Detract from relationships
Center doesn't encourage
Reduce billable hours
Don't help me do work

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0

1=Not significant, 5=Extremely significant
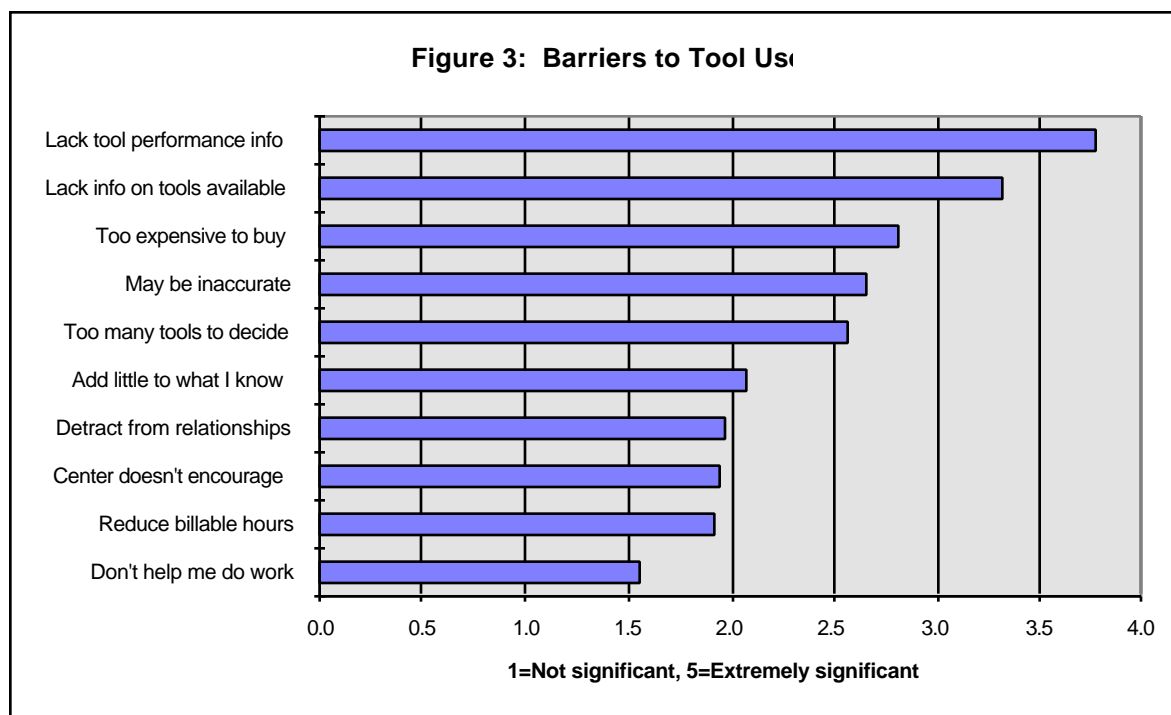
Tested for statistical significance, the barriers with the next three highest scores all fall within the same range between moderately significant and significant. Scores for these barriers show some concern among field staff regarding the price of tools and their accuracy, and some difficulties with sorting through all the tools and deciding which ones to use.

Of the remaining five potential barriers, only the last one--"I don't believe tools can help me do my work"--is statistically different from the others with its score of 1.55.
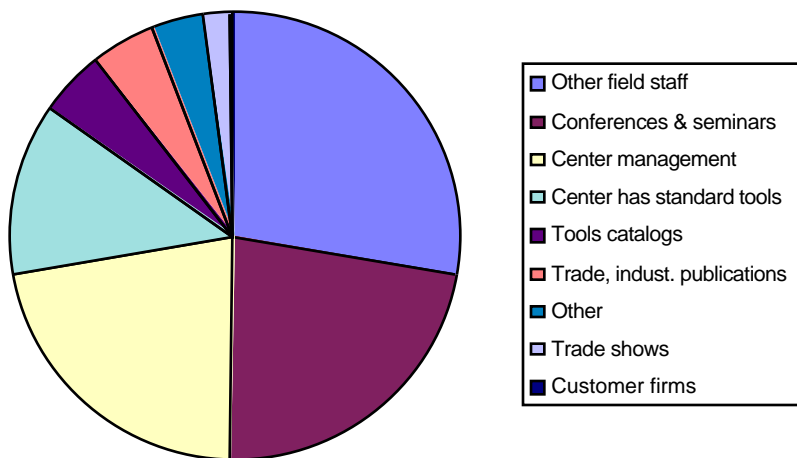
A comparison was made of answers to this barriers question from tool users and non-users. Only one difference between these two sets of respondents proved to be statistically significant --field staff who use tools placed less significance (1.8) on the barrier "My extension center doesn't encourage tool use by field staff" than did non-users (2.4).

Responses to the barriers question demonstrate that a lack of information is a significant obstacle to tool use by field staff. The sources of information that field staff now tap to learn about tools fail to adequately inform them about how tools perform and what tools are available.

The questionnaire asked tool users to indicate how they hear about manufacturing extension tools by checking off as many sources as were applicable from a list of nine. *Figure 4* on the following page shows the breakdown for 314 answers provided by 151 respondents.

Two of the three most common sources of information are informal ones close to home: 88 (58.3 percent) of the respondents reported that they hear about tools from other manufacturing extension field staff, and 68 (45.0 percent) said they learn about them through extension center directors and managers. The only other source checked by close to half the respondents was "Conferences and seminars" with 70 tallies (46.4 percent). As for the other less formal sources of information, 15 respondents cited trade and industry publications and six acknowledged trade shows. Only one respondent checked the option "Customer firms" when answering this question.

Figure 4: How Respondents Hear About Tools

Legend:
- Other field staff
- Conferences & seminars
- Center management
- Center has standard tools
- Tools catalogs
- Trade, indust. publications
- Other
- Trade shows
- Customer firms

Fewer respondents reported drawing upon more formal sources for tools information. Fifteen (9.9 percent) said they use tools catalogs, and 40 (26.5 percent) reported that their center has a standard set of tools for use with firms. The number of respondents citing a standard tool set at their center is surprisingly high given what's known about center practice regarding tools. In all likelihood, it overstates the prevalence of tools standardization among the centers.

To further investigate this question, the Modernization Forum tallied the number of individuals from each center who checked off the standard tool set option and compared this count with the total number of individuals from that center who responded to the survey. It's reasonable to assume that if a center uses a standard set of tools, more than half of the respondents from that center will have acknowledged that tool set in their survey responses.

Respondents from 22 different extension organizations reported that they hear about tools because their center has a standardized set. However, in only three cases did more than half of the respondents from one of these 22 centers acknowledge a standard tool set when answering the survey. Those three centers are the Industrial Technology Assistance Corp. in New York City, the Institute of Advanced Manufacturing Sciences in Cincinnati, and the Wisconsin Manufacturing Extension Partnership. In one extreme case, only one of 16 respondents from a Midwestern center cited a standard tool set. Some of these discrepancies may stem from operational differences among the regional offices of a center. Additional research into individual responses and center practices could yield more insights into which centers use a standard tool set and how.

The data on barriers to tool use, when coupled with data on how respondents hear about tools, indicate that the less formal word-of-mouth sources fall short of adequately providing field staff with information about tools and tool performance.

Tools for What Functions

One of the questions included in the survey attempted to determine the types of functions for which field staff would like to have tools. Respondents were asked to indicate how desirable it is to have tools for a list of eight extension center functions using the following scale:

        1 = Not desirable
        2 = Moderately desirable
        3 = Desirable
        4 = Very desirable
        5 = Extremely desirable

Figure 5 shows the average scores for each type of function.

Figure 5: Functions for Tools

1=Not desirable, 5=Extremely desirable
(Note: Limited statistical difference among values)
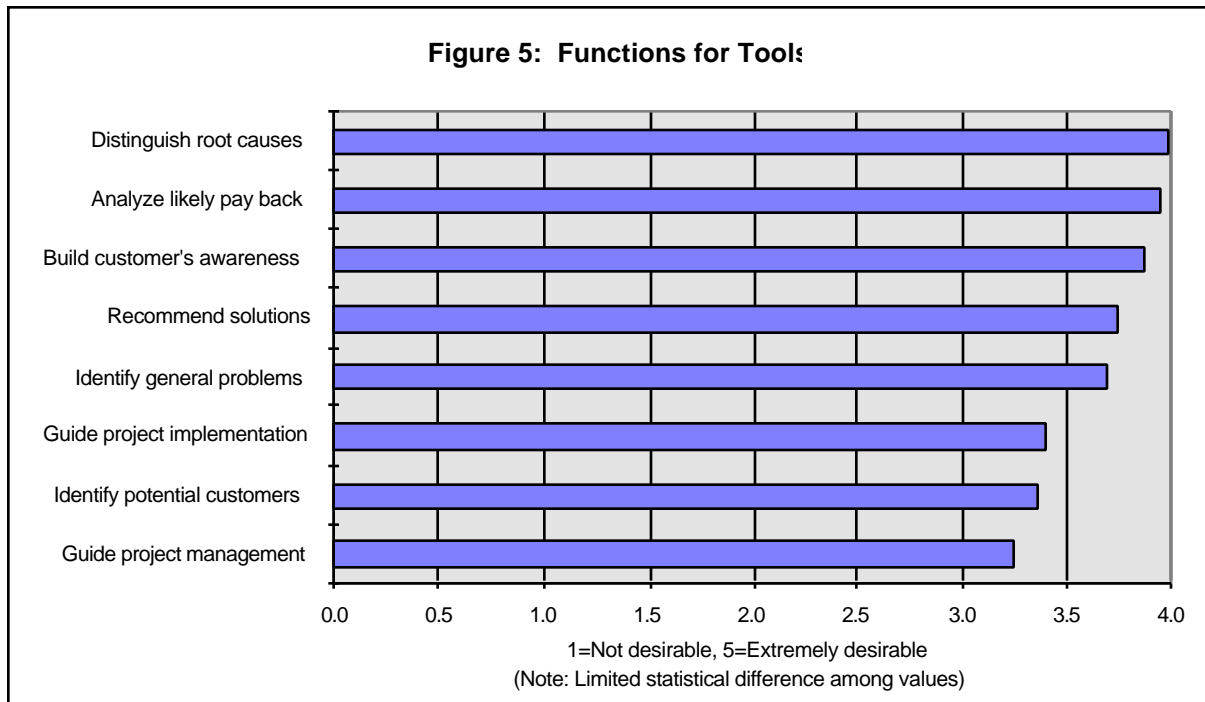
The average scores for each of the eight functions--from a high of 4.0 to a low of 3.2--all fall within a close range between desirable and very desirable. The top four functions for which respondents most desired tools cluster around "very desirable"--and tested for statistical significance they all may be considered equal in value. Interestingly the types of functions in this top grouping differ considerably in scope, from analyzing root causes to building awareness. Two of the three lowest scoring functions--all of which are of equal value when tested for statistical significance--relate to project work: "Guiding implementation decisions during a project" and "Guiding project management." There was no statistically significant differences between how tool users and non-users answered this question.

Conclusions and Recommendations

A number of important findings emerge from the data analysis of the tools-in-use survey. First tool use is common among field staff. More than seven in 10 of the survey respondents reported that they use manufacturing extension tools when working with customer firms. This is an important and encouraging discovery.

Types of Tools Used

Two initial, overall assessment tools stand out by far as the ones that field staff are most likely to use. Performance Benchmarking and QuickView each are used by about two-thirds of the tool users who responded to the survey, and each had more than twice as many users as the third-ranking tool, fisCAL. Many of the respondents use both Performance Benchmarking and QuickView, indicating that the tools serve somewhat distinct markets.

Overall assessment tools in general are popular among extension center field staff. Overall assessments account for seven of the 22 tools used by more than 5 percent of the tool users who responded to the survey. These included the full range of assessments, from initial, general and diagnostic assessments such as QuickView, to in-depth, diagnostic and prescriptive ones, such as PRISM. Subject-specific assessments, which focus more narrowly on particular manufacturing or business issues, accounted for many of the other tools used by 5 percent or more of the tool-using respondents. The survey also found relatively high use of software selection tools and tools for simulating production and mapping flow.

Notable Tools for Manufacturing Extension Work

Drawing from the survey data, it is possible to compile a list of notable tools for manufacturing extension. *Table 6* on the following page lists 29 tools that meet any of the criteria listed below. The columns to the right on the table indicate which of these criteria each tool meets. The ISO 9000/QS9000 gap analysis, cited as one of the most useful tools by three respondents, is not included on this list because of questions about whether that name refers to a separate tool or is a generic informal reference to other quality-focused tools. In addition the list leaves off the generic "CTS" because the five respondents who wrote this in failed to specify whether they were referring to the CTS Guide to PC-Based Software or the CTS Cost-Justifier.

Criteria for Notable Extension Tools

- Used by 5 percent or more of the tool users who responded to the survey
- Written in by three or more respondents as among the most useful tools for extension work
- Used by at least three experienced extension field engineers

Of the 29 tools listed in *Table 6*, 12 were developed at manufacturing extension organizations, 12 are the commercial products of for-profit companies, three come from federal government agencies, one is from the National Center for Manufacturing Sciences, and one is free shareware. (One center-developed tool, the Software Selection Tool, is now owned by a private, for-profit company.) This breakdown of tools by source demonstrates the importance of tools available from both inside and outside the manufacturing extension network.

Table 6
Notable Tools for Manufacturing Extension

Name of Tool	Used by 5% or More of the Tool Users	Cited by 3 or More Respondents as Most Useful to Extension Work	Used by 3 or More Experienced Respondents
Performance Benchmarking	X	X	X
QuickView	X	X	X
fisCAL	X	X	X
Factory CAD, Flow, Plan	X	X	X
Software Selection Tool (SoftSelect Software)	X	X	X
SITE Assessment	X	X	X
Z Score	X	---	X
CTS Guide to PC-Based Software	X	X	X
OSHA Self-Inspection Checklist	X	---	X
High Impact Assessment and BI-FAR	X	X	X
Manufacturing Assessment Methodology	X	X	X
BizPlan Builder	X	---	X
ProModel	X	X	X
BuySmart/ChooseSmart	X	---	X
ISO 9000 Checklist from Georgia Tech	X	X	X
Energy, Environmental and Mfg Assessment	X	X	---
CAD Rating Guide	X	---	X
SAGE	X	---	---
Competitiveness Review	X	X	---
CorelFLOW	X	---	X
DISC--Personality Profile for Managers	X	---	X
PRISM Manufacturing Assessment	X	X	X
Human Resources Assessment Protocol & Mini	---	X	X
CTS Cost-Justifier for Manufacturing	---	X	---
ISO Score	---	X	---
Microsoft Project	Not listed	X	---
TECnet (information resource)	Not listed	X	---
Work Profiling System	Not listed	X	---
Total Quality Joining Assessment Methodology		---	X

The listing in *Table 6* is an inclusive one, showing all the tools that meet any one of the three criteria used as a screen. The table can serve as a baseline for constructing more restrictive lists if desirable. For example, a more limited roll or top tools might include only the 14 that

were cited by three or more respondents as among the most useful *and* (not or) which are used by 5 percent or more of the tool users who responded to the survey.

Barriers to Tool Use

The two most significant barriers to tool use are information barriers. On average survey respondents rated as significant to very significant barriers stemming from a lack of information about how well tools perform and a lack of information about tools. This indicates that the sources field staff now turn to for information about tools fail to meet their needs. Data from the survey show that they mostly hear about tools through informal channels, such as other field staff and extension center management.

Recommendations

- Manufacturing extension centers and the field staff who work for them should be made aware of the 29 tools listed in *Table 6*. These tools are notable because of the relatively high number of survey respondents who use them, the number of respondents who cited them as among the most useful tools for extension work, or the number of respondents with three years or more of extension experience who use them. Extension centers could benefit from information about each of these tools and their performance--at the least how current users rate that performance. Other useful tools exist, and information about these should also be compiled and shared. But the list in *Table 6* presents a starting point for tools which should be widely known throughout the manufacturing extension network.

- Interested organizations must find more effective means for disseminating information about manufacturing extension tools to field staff. Data from the survey demonstrate that lack of information about tool performance and lack of information about tools are significant barriers to tool use. All the organizations that have been involved in providing tools information to extension centers--notably the NIST MEP, the Southern Technology Council, the Modernization Forum and the Industrial Technology Institute--need to cooperate on efforts that address this issue. Furthermore the information that is disseminated must be more complete. The two most extensive catalogs of extension tools--STC's *Information Tools for Industry* and NEM's *Tools of Our Trade*--omit, respectively, eight and seven of the top 15 tools as measured by number of users counted for this survey.

- The NIST MEP and manufacturing extension centers should closely examine existing tools, both commercial ones that for-profit companies develop and which could be adopted or adapted for manufacturing extension use, and ones developed at extension centers. Given the high cost involved in developing new tools from scratch, centers should identify their tool needs and tap existing tools from all sources whenever possible.

- Further analysis and research regarding tools use should be done building off this tools-in-use survey. The analysis presented in this report focuses on tools--counting how many respondents use them and how many cite them as among the most useful to extension work. The database of tools-in-use survey responses also could be culled to look not only at the tools but also the tool users--which field engineers use many different tools and which use them more frequently than most field staff. Interviews and focus group sessions with field staff who use tools extensively could yield useful insights into tool use strategies, tools evaluation and effective methods for disseminating information about tools. In addition, further research could yield useful information about which centers employ a standard tool set, what they include in it, and how they use it.

Appendices